Lawrence Livermore National Laboratory

Program Update - September 2000

# Laser Science & Technology

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## Fabrication of 160-kW Diode-Laser Arrays Now Completed

We have completed a 160-kW peak-power diode array for use in pumping the Yb:S-FAP slabs that serve as the gain medium in the Mercury laser. This diode array uses a low-cost packaging technology developed at LLNL for moderate duty factor application. In our approach, diode submounts or tiles are fabricated using a silicon etching technology. These tiles serve to precisely position and hold 23 laser diode bars. The precision positioning that is enabled by the silicon submount allows the use of high-precision cylindrical microlenses to be located in front of each diode bar as shown in Figure 1 below. The lenses, which collimate the highly divergent “fast-axis” diode radiation, are critical for the production of high-radiance pump beams that will be used to excite laser crystals at high irradiances. With each bar typically being able to generate in excess of 100 W of peak power, an individual tile is capable of sourcing in excess of 2.3 kW of pump radiation. Large pump arrays are built up by juxtaposing individual diode tiles.

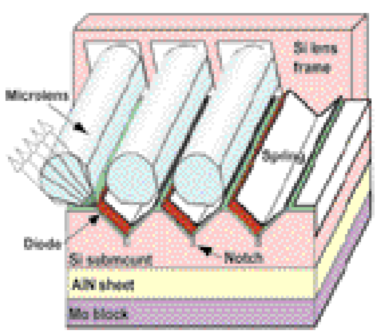


**Figure 1. LLNL-developed low-cost diode laser submount uses silicon etching technologies to fabricate a structure that can precisely hold 23 diode bars on an individual tile.**

On an individual tile the diode bars are electrically connected in series. A typical current pulse to the tiles will have up to a 1-ms duration and a peak amplitude of 140 amps. Figure 2 shows the optical output power of one tile as a function of the drive current peak amplitude. The peak optical output power from the array is 2.75 kW and incorporates an almost 20% safety margin over the performance level.

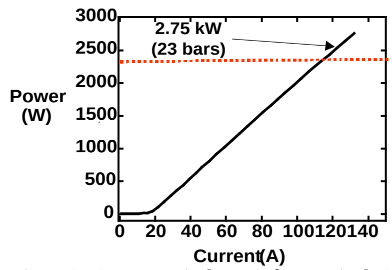


**Figure 2. Output optical power from a single 23-bar tile as a function of the drive current applied to the tile. The red line indicates the minimum acceptable level for the Mercury laser.**

The Mercury laser will utilize four groups of tiles, each group referred to as a backplane array, which will be used to end-pump the Yb:S-FAP laser slabs. Each of the four backplanes will consist of 72 individual tiles. We have completed fabrication of the tiles for one of the backplanes, which will generate in excess of 160 kW of peak optical power and be used to perform preliminary experiments. Figure 3 below shows 42 of the 72 tiles that will be used in constructing the first Mercury backplane array.

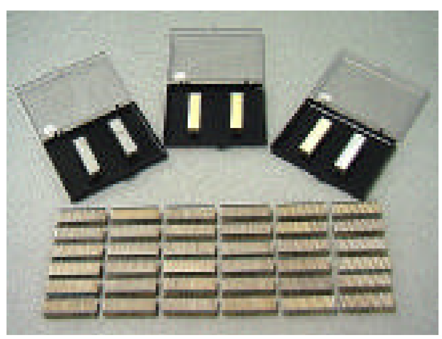

**Figure 3. Mercury laser backplane array.**

***(Barry Freitas)***

## Deuterium Cluster Fusion Neutron Pulse Width Characterized

Last year we reported the first observation of nuclear fusion from the explosions of ultrafast laser-heated deuterium clusters. A picture of the apparatus used for laser irradiation experiment is shown in Figure 4. Since that initial experiment, the Falcon team has undertaken a series of experiments to characterize the phenomenon and to assess the viability of this technique with a much higher average-power laser to yield useful, small-scale neutron sources for materials irradiation.

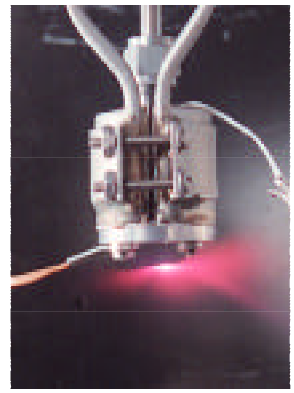

**Figure 4. Falcon gas jet neutron source.**

The most striking result has been the measurement of the neutron pulse duration. These measurements have shown that the emitted neutron pulse at the interaction point has duration of only a few hundred picoseconds (see Figure 5), consistent with fusion reactions in an inertially confined hot deuteron plasma. The spread in neutron pulse width with distance arises from the finite energy spread of the 2.45 MeV neutrons produced by the temperature of the reacting plasma (multi-keV).

This result is intriguing as it may ultimately enable a new class of experiments in which a short neutron pulse is used as a pump to trigger dynamics in a material that can then be probed as a function of time with a second optical or x-ray pulse.

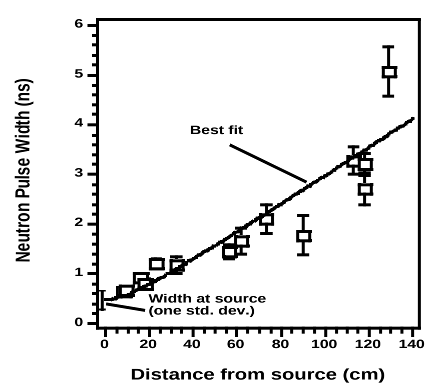


**Figure 5. Measured neutron pulse width as a function of distance from the cluster plasma.** ***(Todd Ditmire)***

For comments about content of the *LS&T Program Update*, contact Dr. Hao-Lin Chen (925) 422-6198.
To get on the mailing list of the *LS&T Program Update*, send a request to Linda Ortega, ortega4@llnl.gov
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